Beyond viability: comparative functional evaluation of live and inactivated industrial biomasses of probiotic lactobacilli

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Keywords: Probiotics, Paraprobiotics, Postbiotics, Lactobacilli, Caco-2 cells, NF-κB, TLR2.

Abstract:

Non-viable microbial cells are increasingly used as postbiotic or paraprobiotic ingredients, yet the functional impact of industrial inactivation remains poorly characterized. This study provides an integrated functional analysis of industrially fermented, inactivated, and lyophilized probiotic biomasses.

Four probiotic strains (*Lacticaseibacillus rhamnosus* LRH020, *Lactobacillus acidophilus* PBS066, *Lactiplantibacillus plantarum* PBS067, and *Lacticaseibacillus paracasei* LPC1114) and their corresponding industrial biomasses were examined. Multiple thermal and mechanical inactivation protocols were compared. Flow cytometry showed complete loss of culturability and viability-associated markers in all non-viable biomasses. Functional assays revealed strain- and protocol-dependent effects on epithelial adhesion and Toll-like receptor 2 (TLR2) engagement. For LRH020, one thermal protocol consistently preserved adhesion and TLR2 activation across three industrial batches, whereas high-pressure processing abolished adhesion. Anti-inflammatory activity, assessed as inhibition of IL-1β-induced nuclear factor kappa B (NF-κB) activation in Caco-2 cells, was retained in all LRH020 and PBS066 biomasses, but absent in PBS067 and LPC1114.

Industrial inactivation shapes the functional properties of non-viable probiotic biomasses. The biological potency of postbiotic/paraprobiotic ingredients depends on the specific strain-process combination, underscoring the need to use industrially produced materials, rather than laboratory cultures, for preclinical characterization and nutritionally relevant postbiotic development.

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